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[Title of the Invention] LIQUID CRYATAL SUBSTRATE BONDING METHOD

[Abstract]

[Object] There is provided a method of bending two sheets of substrates of a liquid crystal display device which can improve throughput and quality while ensuring a gap accuracy of two sheets of substrates.

[Solving Means] For two sheets of opposite substrates bonding, one substrate 23 is mounted on a board 24 and fixed to a fixing pin 25, the other substrate 26 is fixed with an absorption apparatus 27 having a groove hole diameter of less than 3 mm or a groove width of less than 3 mm through vacuum absorption, the one substrate and the other substrate are relatively moved to match a position, and then, pressed and thus the one substrate and the other substrate are bonded through an adhesive 21.

[Claims]

[Claim 1] A liquid crystal substrate bonding method comprising:

fixing a lower substrate having an adhesive coated on a substrate surface and a liquid crystal material inserted, in a vacuum chamber, such that the adhesive side and the liquid

crystal material side face upward;

fixing an outer overall surface of an upper substrate arranged in a predetermined interval to face the lower substrate through vacuum absorption using an absorption portion having a groove hole diameter of less than 3 mm or a groove width of less than 3 mm;

relatively moving both of the upper and lower substrates in a substrate surface direction to match a position;

moving and pressing at least one substrate in a direction perpendicular to the substrate surface; and

bonding the upper and lower substrates.

[Claim 2] The liquid crystal substrate bonding method according to Claim 1, wherein the outer overall surface of the lower side of the lower substrate is fixed through the vacuum absorption using the absorption portion having a groove hole diameter of more than 0.5 mm and less than 3 mm or a groove width of more than 0.5 mm and less than 3 mm.

[Claim 3] A liquid crystal substrate bonding method comprising:

arranging a spacer on a lower side of a lower substrate having an adhesive coated on a substrate surface and a liquid crystal material inserted, in a vacuum chamber, in a region of the adhesive and the liquid crystal material;

fixing the spacer to a pressing unit such that the

adhesive side and the liquid crystal side face upward;

fixing an outer overall surface of an upper substrate arranged in a predetermined interval to face the lower substrate through vacuum absorption using an absorption portion;

relatively moving both of the upper and lower substrates in a substrate surface direction to match a position;

moving and pressing at least one substrate in a direction perpendicular to the substrate surface; and

bonding the upper and lower substrates.

[Claim 4] The liquid crystal substrate bonding method according to Claim 3, wherein the spacer is also arranged on an upper side of the upper substrate in a region corresponding to the region of the adhesive and the liquid crystal material of the lower substrate.

[Claim 5] The liquid crystal substrate bonding method according to Claim 3, wherein the upper substrate is fixed using the absorption portion.

[Claim 6] The liquid crystal substrate bonding method according to any one of Claims 1 to 5,

wherein the absorption portion includes a plurality of absorption holes, and

wherein an absorption hole aperture ratio of a surface contacting with an absorption board of the substrate to an

overall area is more than 50%.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a method of bonding a liquid crystal substrate such as a liquid crystal device for use in an image display panel such as a personal computer or a TV receiver.

[0002]

[Description of the Related Art]

A substrate bonding method of a liquid crystal device is described with reference Figs. 5 to 7. An arrangement of the liquid crystal device has a lower substrate 1 and an upper substrate 2 with a constant gap, in which the substrates are made of a transparent material and an ultraviolet curing type adhesive 3 is arranged therebetween, as shown in Fig. 5. In Fig. 5, an adhesive in a shape of four angled frame is coated in advance on the lower substrate, and then, the upper substrate 2 is covered thereon so that it is adhered to the adhesive. In addition, as shown in Figs. 6A to 6C, one example method of arranging the liquid crystal material 4 on the adhesive 3 is a liquid dropping method including coating the adhesive 3 in a shape of four angled frame and in a thickness of 30 μm on the

surface of the lower substrate 1, and then, overlapping the upper substrate 2 thereon to press the upper substrate 2 and the lower substrate 1 up to 5 μm, and curing the adhesive 3 by ultraviolet 5 to complete the panel.

[0003]

A method of bonding two sheets of substrates will now be described in detail with reference to Figs. 7A to 7D. First, as shown in Fig. 7A, the ultraviolet curing type adhesive 3 coated on the surface in a shape of four angled frame and in a thickness of 30 μm, and the lower substrate 1 having the liquid crystal 4 arranged in the four frame of the corresponding adhesive 3 are mounted on a table 6 which is movable in the horizontal direction, and the surrounding thereof is fixed to a fixing pin 7. Next, as shown in Fig. 7B, an outer overall of the other upper substrate 2 arranged in a predetermined gap is fixed to face the lower substrate 1 through vacuum absorption using the absorption apparatus 8. Next, as shown in Fig. 7B, in the vacuum chamber C, a table having the lower substrate 1 mounted thereon is moved in a horizontal direction, to match a position between the lower substrate 1 and the upper substrate 2. Next, as shown in Fig. 7C, in the vacuum chamber C, the upper substrate 2 is pressed up to 5 μm in a vertical direction, and the upper substrate is bonded to the lower substrate 1 through the adhesive 3. Next, as shown in Fig. 7D, ultraviolet 5 is

illuminated to cure the adhesive 3, and thus the bonding between the lower substrate 1 and the upper substrate 2 is completed.

[0004]

[Problems to be Solved by the Invention]

However, in the conventional method, each absorption hole of the absorption apparatus 8 that absorbs the entire outer surface of the substrate 2 has a hole diameter of more than 5 mm, or a groove width of a absorption groove portion of more than 5 mm, so that substrate deformation is increased in the air or vacuum, and in particular, in case of the upper substrate 2 having a plate thickness of 0.7 mm, the substrate is partially and significantly floated in the absorption hole or the absorption groove portion, and a gap accuracy with the lower substrate 1 is more than 0.1 μm, and thus there is a problem of image spot defects due to a non-uniform gap. To avoid the substrate deformation, when each absorption hole of the absorption apparatus 8 has a hole diameter of less than or equal to 0.5 mm, or a groove width of the absorption groove portion of less than or equal to 0.5 mm, an effective resistance at each absorption hole or the absorption groove portion of the absorption apparatus 8 grows large, so that there is a problem in that a predetermined absorption capability is not obtained. In addition, a region other than the region where the adhesive

3 and the liquid crystal 4 are arranged is pressed, so that the region other than the region of the adhesive 3 of the upper substrate 2 and the lower substrate 1 is deformed inwardly between the upper substrate and the lower substrate, and thus due to a repulsion, the region of the adhesive 3 and the liquid crystal 4 is partially deformed outwardly between the upper substrate and the lower substrate and significantly floated and a gap accuracy is more than 0.1 μm. Therefore, there is a problem of image spot defect due to a non-uniform gap. Therefore, to order to solve the above problems, there is provided a method of bonding a liquid crystal substrate of a liquid crystal display device, which can remove the non-uniform gap in the region of the adhesive and the liquid crystal material, suppress the gap accuracy within 0.1 μm, remove the image spot defect, and attempt to improve the product throughput and quality.

[0005]

[Means for Solving the Problems]

To accomplish the above object, the present invention is configured as described below. One aspect of the present invention provides a liquid crystal substrate bonding method comprising: fixing a lower substrate having an adhesive coated on a substrate surface and a liquid crystal material inserted, in a vacuum chamber, such that the adhesive side and the liquid crystal material side face upward; fixing an

outer overall surface of an upper substrate arranged in a predetermined interval to face the lower substrate through vacuum absorption using an absorption portion having a groove hole diameter of less than 3 mm or a groove width of less than 3 mm; relatively moving both of the upper and lower substrates in a substrate surface direction to match a position; moving and pressing at least one substrate in a direction perpendicular to the substrate surface; and bonding the upper and lower substrates. With the above arrangement, a gap accuracy of two sheets of substrates arranged at opposite positions can be suppressed to be less than 0.1 μm.

[0006]

Another aspect of the present invention provides the liquid crystal substrate bonding method claimed in Claim 1, in which the outer overall surface of the lower side of the lower substrate is fixed through the vacuum absorption using the absorption portion having a groove hole diameter of more than 0.5 mm and less than 3 mm or a groove width of more than 0.5 mm and less than 3 mm. With the above arrangement, a gap accuracy of two sheets of substrates arranged at opposite positions can be suppressed to be less than 0.1 μm.

[0007]

Still another aspect of the present invention provides a liquid crystal substrate bonding method comprising:

arranging a spacer on a lower side of a lower substrate having an adhesive coated on a substrate surface and a liquid crystal material inserted, in a vacuum chamber, in a region of the adhesive and the liquid crystal material; fixing the spacer to a pressing unit such that the adhesive side and the liquid crystal side face upward; fixing an outer overall surface of an upper substrate arranged in a predetermined interval to face the lower substrate through vacuum absorption using an absorption portion; relatively moving both of the upper and lower substrates in a substrate surface direction to match a position; moving and pressing at least one substrate in a direction perpendicular to the substrate surface; and bonding the upper and lower substrates. With the above arrangement, a gap accuracy of two sheets of substrates arranged at opposite positions can be suppressed to be less than 0.1 μm.

[0008]

Still another aspect of the present invention provides a liquid crystal substrate bonding method claimed in Claim 3, in which the spacer is also arranged on an upper side of the upper substrate in a region corresponding to the region of the adhesive and the liquid crystal material of the lower substrate. With the above arrangement, a gap accuracy of two sheets of substrates arranged at opposite positions can be suppressed to be less than 0.1 μm.

[0009]

Still another aspect of the present invention provides a liquid crystal substrate bonding method claimed in Claim 3, in which the upper substrate is fixed using the absorption portion. With the above arrangement, a gap accuracy of two sheets of substrates arranged at opposite positions can be suppressed to be less than 0.1 μm.

[0010]

Still another aspect of the present invention provides a liquid crystal substrate bonding method claimed in Claims 1 to 5, in which the absorption portion includes a plurality of absorption holes, and an absorption hole aperture ratio of a surface contacting with an absorption board of the substrate to an overall area is more than 50%.

[0011]

[Embodiments]

Preferred embodiments of the present invention will now be described in detail with reference to the accompanying drawings.

[0012]

(First Embodiment)

As an example liquid crystal substrate bonding method according to a first embodiment of the present invention, a method of bonding two sheets of substrates will be described in the context of a liquid crystal device, with reference to

Figs. 1A, 1B, 1C, and 1D. Figs. 1A, 1B, 1C, and 1D are a schematic cross sectional view for explaining a bonding method. First, as shown in Fig. 1A, an ultraviolet curing type adhesive 21 coated in a shape of a four angled frame and, for example, in a thickness of 30 μm, and a liquid crystal material 22 in the four angled frame of the adhesive 21 are arranged on a surface through a dropping method and the like, and in addition, a lower substrate 23 made of a transparent material is mounted on a table 24 which is movable in a horizontal direction, and a circumference of the lower substrate 23 is fixed with the fixing pin 25 to the table 24 so as not to be movable (step S1). The fixing method may be absorption. An example of the table 24 may be an XY table that can independently reciprocate or rotate within a horizontal direction surface in two directions, i.e., the X direction and the Y direction perpendicular thereto, using X and Y direction driving devices, respectively. In addition, the thickness of the adhesive 21 is not limited to 30 μm, and it may be 15 μm to 35 μm, as another example.

[0013]

Next, as shown in Fig. 1B, the lower substrate 23 fixed to the table 24 is put into the vacuum chamber C, and an outer overall surface of the upper substrate 26, i.e., an upper surface in Fig. 1C made of a transparent material is

fixed through the vacuum absorption (e.g., vacuum absorption used to cause a pressure of an absorption portion 27a to be about 0.1 Torr), using an absorption board 27, which is connected to a vacuum absorption device 127, having the absorption portion 27a such as a plurality of absorption holes each having a hole diameter of less than 3 mm or a groove width of the absorption groove portion of less than 3 mm, and then, the inner overall surface of the upper substrate 26, i.e., the lower surface in Fig. 1B is arranged such that the lower surface extends along the horizontal direction. Next, the table 24 having the lower substrate 23 mounted thereon is moved in a horizontal direction, and position matching is performed between the lower substrate 23 and the upper substrate 26 (step S2). A specific example of a transparent material of the upper substrate 26 and a specific example of the material of the lower substrate 23 are glass or plastic.

[0014]

In addition, Fig. 8B is a plan view of an example arrangement of a plurality of absorption holes, in which each of absorption holes 27a-2 arranged in a region corresponding to a substrate surface of the absorption board has a hole diameter 3 of less than 3 mm, as an example of an arrangement of the absorption portion 27a of the absorption board 27. Figs. 8A and 8C are, respectively, an example

arrangement of the absorption portion 27a of the absorption board 27, which shows a plan view of an example arrangement of the absorption groove portion 27a-1 in a rectangular shape having a groove width of less than 3 mm, arranged in a region corresponding to the substrate surface of the absorption board 27, and a plan view of an example arrangement of an absorption groove portion 27a-3 in a rectangular helical shape having a groove width of less than 3 mm. At this time, in a case where more than 50% aperture area of an opening of all absorption holes or absorption groove portions of the absorption board 27 is secured, i.e., more than 50% aperture ratio of an absorption hole or an absorption groove portion to the entire area of a surface contacting to the absorption board 27 of the substrate is secured, when the substrate is determined to be glass, it is possible to lift the substrate made of glass having a thickness of 0.7 mm in a state of chamber pressure of 0.8 Torr. In addition, in order to ensure that the conventional drawbacks are avoided when the hole diameter of each absorption hole of the absorption apparatus is less than 0.5 mm, or the groove width of the absorption groove portion is less than 0.5 mm, a hole diameter of each absorption hole of the absorption apparatus is determined to be more than 0.5 mm and less than 3 mm, or the groove width of the absorption groove portion is determined to be more than 0.5 mm and less

than 3 mm. In addition, to actually use it safely, it is desirable that an aperture ratio of the absorption hole is more than 70%.

[0015]

Next, as shown in Fig. 1C, using a pressing device 128 like an air cylinder as an example of a pressing unit, the absorption board 27 moves down in a vertical direction, the upper substrate 26 is bonded to the lower substrate 23 through the adhesive 21, and a gap between the upper substrate 26 and the lower substrate 23 is pressed up to 5 μm (step S3). In addition, the present invention is not limited to pressing the gap between the upper substrate 26 and the lower substrate 23 up to 5 μm, but when the gap is 8 μm, the gap may be pressed up to more or less 3 μm. Next, as shown in Fig. 1D, the two bonded substrates 26 and 23 are pulled out from the vacuum chamber C along with the table 24, and ultraviolet is illuminated from an ultraviolet illumination lamp 28 from above the two bonded substrates 26 and 23. At this time, the upper substrate 26 is made of a transparent material, so that it can transmit ultraviolet from the ultraviolet illumination lamp 28, and ultraviolet can be illuminated to the adhesive 21 between two bonded substrates 26 and 23, so that the corresponding adhesive 21 is ultraviolet cured, and the bonding between the lower substrate 23 and the upper substrate 26 is completed (step

S4).

[0016]

With the above method, when a pressure of the absorption portion 27a is about 0.1 Torr level, the hole diameter of each absorption hole of the absorption board 27, or the groove width of each absorption groove portion is determined to be less than 3 mm (preferably, more than 0.5 mm, and less than 3 mm), so that a gap accuracy of two sheets of substrates 26 and 23 arranged at opposite positions can be suppressed up to less than 0.1 μm, and image spot defects can be removed. With respect to this, when the hole diameter of each absorption hole of the absorption portion 27a of the absorption board 27 or the groove width of each absorption groove portion is more than 3 mm, the substrate deformation due to the absorption becomes larger, and the gap accuracy of two sheets of substrates 26 and 23 cannot be suppressed up to less than 0.1 μm, so that image spot defects can be generated.

[0017]

In addition, as shown in Fig. 2, an outer overall surface of the lower side of the lower substrate 23, i.e., the overall lower side may be fixed through vacuum absorption using an absorption board 120 having an absorption portion 120a such as a plurality of absorption holes having each hole diameter connected to a vacuum

absorption device 120 of less than 3 mm (preferably, more than 0.5 mm and less than 3 mm) or having the groove width of less than 3 mm (preferably, more than 0.5 mm and less than 3 mm). Fig. 2 shows an example state in which the absorption board is arranged on a surface of the table 24.

[0017]

(Second Embodiment)

As an example liquid crystal substrate bonding method according to a second embodiment of the present invention, a method of bonding two sheets of substrates will be described in the context of a liquid crystal device, with reference to Figs. 3A, 3B, 3C, and 3D and Fig. 4. Figs. 3A, 3B, 3C, and 3D are a schematic cross sectional view for explaining a bonding method. First, as shown in Fig. 3A, an ultraviolet curing type adhesive 21 coated in a shape of a four angled frame and, for example, in a thickness of 30 µm, and a liquid crystal material 22 in the four angled frame of the adhesive 21 are arranged on a surface through a dropping method and the like, and in addition, a spacer is arranged on the lower side of the lower substrate 23 made of a transparent material in a region corresponding to the region of the adhesive 21 and the liquid crystal 22, the lower substrate 23 is mounted on a table 24 which is movable in a horizontal direction, and a circumference of the lower substrate 23 is fixed with the fixing pin 25 to the table 24

so as not to be movable (step S11). An example of the table 24 may be an XY table that can independently reciprocate or rotate within a horizontal direction surface in two directions, i.e., the X direction and the Y direction perpendicular thereto, using X and Y direction driving devices, respectively. The spacer 29 is made of, for example, a rubber, and has a thickness of 0.5 to 3 mm. As a shape thereof, a plurality of absorption holes are penetrated to absorb the lower substrate 23 to the table 24 through the spacer 29, and the spacer 29 itself is preferably a soft one, having a strength of about $0.1 kg/mm^2$. The spacer 29 is arranged in a region corresponding to the region of the adhesive 21 and the liquid crystal 22, so that the gap accuracy of two sheets of substrates 26 and 23 in the region of the adhesive 21 and the liquid crystal 22 can be guaranteed to be within a predetermined range.

[0019]

Next, as shown in Fig. 3B, the lower substrate 23 fixed to the table 24 is put into the vacuum chamber C, and an outer overall surface of the upper substrate 26, i.e., an upper surface in Fig. 3C made of a transparent material is fixed through the vacuum absorption, using an absorption board 27, which is connected to a vacuum absorption device 127, having the absorption portion 27a such as a plurality of absorption holes each having a hole diameter of less than

3 mm or a groove width of the absorption groove portion of less than 3 mm, and then, the inner overall surface of the upper substrate 26, i.e., the lower surface in Fig. 3B is arranged such that the lower surface extends along the horizontal direction. Next, the table 24 having the lower substrate 23 mounted thereon is moved in a horizontal direction, and position matching is performed between the lower substrate 23 and the upper substrate 26 (step S12).

[0020]

Next, as shown in Fig. 3C, using a pressing device 128 like an air cylinder as an example of a pressing unit, the absorption board 27 moves down in a vertical direction, the upper substrate 26 is bonded to the lower substrate 23 through the adhesive 21, and a gap between the upper substrate 26 and the lower substrate 23 is pressed up to 5 μm (step S13). Next, as shown in Fig. 3D, the two bonded substrates 26 and 23 are pulled out from the vacuum chamber C along with the table 24, and ultraviolet is illuminated from an ultraviolet illumination lamp 28 from above the two bonded substrates 26 and 23. At this time, the upper substrate 26 is made of a transparent material, so that it can transmit ultraviolet from the ultraviolet illumination lamp 28, and ultraviolet can be illuminated to the adhesive between the two bonded substrates 26 and 23, so that the corresponding adhesive 21 is ultraviolet cured, and the

bonding between the lower substrate 23 and the upper substrate 26 is completed (step S14).

[0021]

With the above method, the spacer 29 is arranged in a region corresponding to the region of the adhesive 21 and the liquid crystal 22 of the lower substrate 32, so that a gap accuracy of two sheets of substrates 26 and 23 arranged at opposite positions can be suppressed up to less than 0.1 μm and image spot defects can be removed, irrespective of a flatness of the table 24 or the absorption board 27.

[0022]

In addition, according to the second embodiment in the same manner as in the first embodiment, the absorption portion 27a of the absorption board 27 includes a plurality of absorption holes each having a hole diameter of less than 3 mm (preferably, more than 0.5 mm and less than 3 mm) or an absorption groove portion having a groove width of less than 3 mm (preferably, more than 0.5 mm and less than 3 mm), while obtaining 50% of an opening of the absorption groove portion or all absorption holes for the absorption portion of the absorption board, so that the gap accuracy of two sheets of substrates 26 and 23 arranged at opposite positions can be further guaranteed to be less than 0.1 μm, and the image spot defects can be further removed. With the above arrangement, when the substrate is determined to be

glass, it is possible to lift the substrate made of glass having a thickness of 0.7 mm in a state of chamber pressure of 0.8 Torr. In addition, in order to ensure that the conventional drawbacks are avoided when the hole diameter of each absorption hole of the absorption apparatus is less than 0.5 mm, or the groove width of the absorption groove portion is less than 0.5 mm, a hole diameter of each absorption hole of the absorption apparatus is determined to be more than 0.5 mm and less than 3 mm, or the groove width of the absorption groove portion is determined to be more than 0.5 mm and less than 3 mm. In addition, to actually use it safely, it is desirable that an aperture ratio of the absorption hole is more than 70%. In addition, as shown in Fig. 4, the spacer 30 may be arranged and pressed on the upper side of the upper substrate in a region corresponding to the region of the adhesive 21 and the liquid crystal 22 of the lower substrate 23. An absorption groove portion is also formed in the spacer at approximately the same position as the absorption position of the absorption board 27, and it can be ensured that the spacer 30 allows the upper substrate 26 to absorb the upper substrate 26 through the absorption board 27.

[0023]

With the above method, the spacer 30 is also arranged on the upper side of the upper substrate 26, in a region

corresponding to the region of the adhesive 21 and the liquid crystal 22 of the lower substrate 32, so that a gap accuracy of two sheets of substrates 26 and 23 arranged at opposite positions can be suppressed up to less than 0.1 μm and image spot defects can be removed, irrespective of a flatness of the absorption board 27.

[0024]

[Effect]

As described above, according to the present invention, a gap accuracy of two sheets of substrates can be advantageously improved using a method including fixing a lower substrate in a vacuum chamber; fixing an outer overall surface of an upper substrate through a vacuum absorption using an absorption apparatus having a groove hole diameter of less than 3 mm (preferably, more than 0.5 mm and less than 3 mm) or a groove width of less than 3 mm (preferably, more than 0.5 mm and less than 3 mm); performing a position matching; and moving and pressing the substrates in a direction perpendicular to the substrate surface. More specifically, when a pressure of vacuum absorption through the absorption apparatus is about 0.1 Torr level, a hole diameter of each absorption hole of the absorption apparatus is less than 3 mm (preferably, more than 0.5 mm and less than 3 mm) or a groove width of each absorption groove portion is less than 3 mm (preferably, more than 0.5 mm and

less than 3 mm), a gap accuracy of two sheets of substrates arranged at opposite positions can be suppressed up to, for example, less than 0.1 μm so that image spot defects can be removed. With the above arrangement, when the hole diameter of each absorption or the groove width of each absorption groove portion of the absorption apparatus exceeds 3 mm, the substrate due to the absorption deformed grows larger, and thus the gap accuracy of two sheets of substrates cannot be suppressed up to less than 0.1 μm and image spot defects can be generated. In addition, according to the present invention, in a case where 50% aperture area of an opening of all absorption holes or all absorption groove portions of the absorption board 27 is secured, when the substrate is determined to be glass, it is possible to lift the substrate made of glass having a thickness of 0.7 mm in a state of chamber pressure of 0.8 Torr. In addition, in order to ensure that the conventional drawbacks are avoided when the hole diameter of each absorption hole of the absorption apparatus is less than 0.5 mm, or the groove width of the absorption groove portion is less than 0.5 mm, a hole diameter of each absorption hole of the absorption apparatus is determined to be more than 0.5 mm and less than 3 mm, or the groove width of the absorption groove portion is determined to be more than 0.5 mm and less than 3 mm. In addition, when an aperture ratio of the absorption hole is

more than 70%, it can be used more stably.

[0025]

In addition, using a method including arranging a spacer on a lower side of a lower substrate in a region of an adhesive and a liquid crystal in a vacuum chamber; fixing the spacer to a pressing unit such that the adhesive side and the liquid crystal side face upward; fixing the substrate through vacuum absorption using an absorption portion; performing a position matching; and moving and pressing the substrate in a direction perpendicular to the substrate surface, a gap accuracy of two sheets of substrates can be advantageously improved, irrespective of a flatness of a member having the lower substrate thereon or the absorption board. From the foregoing, while bonding the liquid crystal display device, image defects or image spot defects generated in the prior art can be prevented.

[Brief Description of the Drawings]

[Fig. 1]

Figs. 1A, 1B, 1C, and 1D are schematic diagrams for explaining a method of bonding two sheets of substrates, as a liquid crystal substrate bonding method according to a first embodiment of the present invention.

[Fig. 2]

Fig. 2 is a schematic cross sectional view showing a modified example of a method of bonding two sheets of

substrates according to the first embodiment of the present invention.

[Fig. 3]

Figs. 3A, 3B, 3C, and 3D are schematic cross sectional views for explaining a method of bonding two sheets of substrates, as a liquid crystal substrate bonding method according to a second embodiment of the present invention.

[Fig. 4]

Fig. 4 is a schematic cross sectional view showing a modified example of a method of bonding two sheets of substrates according to the second embodiment of the present invention.

[Fig. 5]

Fig. 5 is an exploded perspective view for explaining an arrangement of a typical liquid crystal display device.

[Fig. 6]

Figs. 6A, 6B, and 6C are cross sectional views for explaining a conventional liquid crystal dropping method.

[Fig. 7]

Figs. 7A, 7B, 7C, and 7D are schematic cross sectional views for explaining a method of bonding two sheets of substrates in the prior art.

[Fig. 8]

Fig. 8A is a plan view of an example arrangement of an absorption groove portion 27a-1 in a rectangular shape and

in a groove width of less than 3 mm, as an example arrangement of an absorption portion 27a of an absorption board 27, Fig. 8B is a plan view of an example arrangement of a plurality of groove holes having each hole diameter of an absorption hole 27a-2 of less than 3 mm, as an example arrangement of the absorption portion 27a of the absorption board 27, and Fig. 8C is a plan view of an example arrangement of an absorption groove portion 27a-3 in a rectangular helical type having a groove width of less than 3 mm.

[Reference Numerals]

21: adhesive

22: liquid crystal material

23: lower substrate

24: table

25: fixing pin

26: upper substrate

27: absorption board

27a: absorption portion

27a-2: absorption hole

27a-1, 27a-3: absorption groove portion

28: ultraviolet illumination lamp

29, 30: spacer

120: absorption board

120a: absorption portion

127: vacuum absorption device

128: pressing device

129: absorption device

C: vacuum chamber